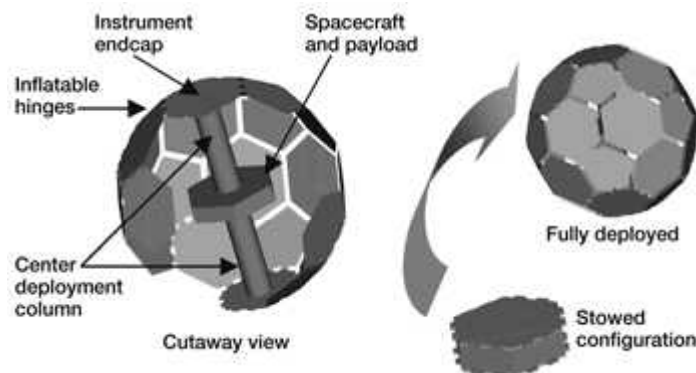


Multifunctional Inflatable Structure Being Developed for the PowerSphere Concept

The continuing development of microsatellites and nanosatellites for low Earth orbits requires the collection of sufficient power for instruments onboard a low-weight, low-volume spacecraft. Because the overall surface area of a microsatellite or nanosatellite is small, body-mounted solar cells cannot provide enough power. The deployment of traditional, rigid, solar arrays necessitates larger satellite volumes and weights, and also requires extra apparatus for pointing. One solution to this power choke problem is the deployment of a spherical, inflatable power system. This power system, termed the "PowerSphere," has several advantages, including a high collection area, low weight and stowage volume, and the elimination of solar array pointing mechanisms.

NASA has funded a collaborative team of the Aerospace Corporation, ILC Dover, Lockheed Martin, and the NASA Glenn Research Center to develop the Multifunctional Inflatable Structure (MIS) for the PowerSphere concept through a NASA Research Announcement (NRA). Glenn is providing overall project and technical management of the effort as well as substantial technical contributions in simulated space environment testing, protective coatings development, and thin-film solar cell technology expertise. As the principle investigator for this development effort, the Aerospace Corporation is leading the technical development effort and is the originator of the PowerSphere concept. ILC Dover is developing the deployable, rigidizable MIS structure that will functionally join the thin-film solar cell panels, flexible power circuitry, and other systems to the central spacecraft payload interface. Lockheed Martin is developing the flexible circuitry elements for the MIS and is also contributing spacecraft integration expertise. The current 3-yr effort will culminate with the fabrication and testing of a fully functional engineering development unit. The PowerSphere MIS component technologies and system-level concept matured sufficiently in fiscal year 2002 to begin proof-of-concept fabrication and testing of MIS systems in fiscal year 2003. Follow-on efforts are also being proposed to further advance the PowerSphere technology to flight readiness for potential spaceflight demonstrations incorporating a number of key power systems technologies.



PowerSphere system concept.

Long description of figure PowerSphere shown in its stowed configuration for launch and in its fully deployed configuration. In the stowed reference configuration, the shape is that of a hexagon approximately 7 inches wide by 4 inches thick. Once fully deployed and rigidized, the reference PowerSphere is a 24-inch sphere composed of hexagonal and pentagonal thin-film solar cells. A third picture depicts a cutaway view showing the central hexagonal payload and center deployment columns on either face of the payload.

The baseline design of the PowerSphere spherical solar array consists of two semispherical domes connected together to a central spacecraft. Each semispherical dome consists of hexagonal and pentagonal solar cell panels that together form a geodetic sphere (see the figure). Inflatable, ultraviolet rigidizable tubular hinges between solar cell panels and ultraviolet rigidizable isogrid center columns with imbedded flex circuitry form the MIS. In a stowed configuration, the solar cell panels are folded sequentially to the outside of the instrument decks. The center column will be z-folded between the instrument decks and the spacecraft housing for packaging. The instrument panel will secure the z-folded stack with launch ties. After launch, once the release tie is triggered, the center column and hinge tubes will inflate and ultraviolet radiation will cure each tube and center column into a rigid supporting column.

The reference configuration for the PowerSphere effort is a 0.6-m-diameter (fully deployed) spacecraft with a total mass of 4 kg (1 kg for the PowerSphere, 3 kg for the spacecraft) capable of producing 29 W of electricity with 10-percent-efficient thin-film solar cells. Potential NASA applications for the PowerSphere include surveys of Earth's Magnetotail, Solar Flotilla missions, planetary protection, sample return missions, multiplatform planet surface science, and formation flying interferometric astronomy science missions. This work is being funded by NASA under contract NAS3-01115.

Bibliography

Prater, Alonzo, et al.: Power Management and Distribution Concept for Microsatellites and Nanosatellites. IECEC SAE Paper 1999-01-2442, 1999.

Gilmore, D., et al.: Thermal Design Aspects of the Powersphere Concept. Paper presented at the 2nd International Conference on Integrated Micronanotechnology for Space Applications, Pasadena, CA, vol. 1, 1999, pp. 451-458.

Simburger, Edward J., et al.: Multifunctional Structures for the PowerSphere Concept. AIAA 2001-1343, 2001.

Glenn contacts: Todd Peterson, 216-433-5350, Todd.T.Peterson@nasa.gov; Tom Kerslake, 216-433-5373, Thomas.W.Kerslake@nasa.gov; and Henry Curtis, 216-433-2231, Henry.B.Curtis@nasa.gov

Author: Todd T. Peterson

Headquarters program office: OAT

Programs/Projects: Space Power Systems R&T

